Khandesh College Education Society's

Moolji Jaitha College, Jalgaon

An "Autonomous College" Affiliated to
KBC North Maharashtra University, Jalgaon

KNOWLEDGE IS POWER

ESTD. 1945

SYLLABUS

Biochemistry

T.Y.B. Sc.

(Semester V & VI)

Under Choice Based Credit System (CBCS)

[w. e. f. Academic Year: 2021-22]

HEAD
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T.Y.B.Sc. Biochemistry (CBCS pattern)

Program Specific Outcomes (PSO)

- T.Y. B.Sc. (Biochemistry) graduates will have basic and applied knowledge of Biochemistry.
- They can further continue their education as PG and then Ph.D.
- After successful completion of the program, students will acquire laboratory and transferable skills which will help them to boost their career.
- Students can apply their knowledge in public as well as private sector and build successful career.

Learning Objectives

- To acquaint the students with various disciplines of Biochemistry.
- To articulate foundation and pillar level knowledge of Biochemistry for the beneficiaries to apply them for advanced studies in the subject.
- To develop practical skills with a sound theoretical background.
- To apply the knowledge gained for higher education, research and profession of their choice.
- To analyse their interests among the various disciplines and implement them in their professional endeavours.

Exam Pattern

- Each theory and practical course will be of 50 marks comprising of 10 marks internal and 40 marks external examination.

External Theory Examination (40 marks)

- External examination will be of two hours duration for each theory course. There shall be 4 questions each carrying equal marks (10 marks each) while the tentative pattern of question papers shall be as follows;
- Q1 (A), Q2 (A) and Q3 (A), each will be of 6 marks (attempt any 2 out of 3 sub-questions).
- Q1 (B), Q2 (B) and Q3 (B), each will be of 4 marks (attempt any 1 out of 2 sub-questions).
- Q4 will be of 10 marks (attempt any 2 out of 3 sub-questions).

External Practical Examination (40 marks):

- Practical examination shall be conducted by the respective department at the end of the semester. Practical examination will be of minimum 3 hours duration and shall be conducted as per schedule. There shall be 05 marks for journal, 10 marks for *viva-voce*. Certified journal is compulsory to appear for practical examination.

Internal Theory/ Practical Examination (10 marks):

- Internal theory assessment of the student by respective teacher will be comprehensive and continuous, based on written test/ assignment. The written test may comprise of both objective and subjective type questions.
- Internal practical examination should be conducted by respective department as per schedule given. For internal practical examination student should perform at least one major and one minor experiment and should have completed journal.

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Structure of T.Y.B.Sc. (Biochemistry) Curriculum Semester V

Discipline	Course Type	Course Code	Course Title	Credits	Hours/ Week (Clock Hours)	Total Teaching hours	Marks	
							Int	Ext
DSC	Core I	BC-351	Genetics	3	3	45	10	40
	Core II	BC-352	Plant Biochemistry and Biofertilizers	3	3	45	10	40
	Core III	BC-353	Clinical Biochemistry	3	3	45	10	40
	Core IV	BC-354	Metabolism	3	3	45	10	40
	Core V	BC-355	Biophysical Chemistry	3	3	45	10	40
	Core VI	BC-356	Fermentation Technology	3	3	45	10	40
SEC	Skill Based	BC-350	Introductory Biostatistics	2	2	30	10	40
DSC	Core (Practical)	BC-357	Practical course in Techniques in Plant Biotechnology and Molecular Biology-I	2	4 / batch	60	10	40
		BC-358	Practical course in Clinical Biochemistry	2	4 / batch	60	10	40
		BC-359	Practical course in Biophysical Chemistry	2	4 / batch	60	10	40

Structure of T.Y.B.Sc. (Biochemistry) Curriculum Semester VI

Discipline	Course Type	Course Code	Course Title	Credits	Hours/ Week (Clock Hours)	Total Teaching hours	Marks	
							Int	Ext
DSC	Core I	BC-361	Genetic Engineering	3	3	45	10	40
	Core II	BC-362	Plant Biotechnology and Biomembranes	3	3	45	10	40
	Core III	BC-363	Immunology	3	3	45	10	40
	Core IV	BC-364	Enzymology	3	3	45	10	40
	Core V	BC-365	Analytical Techniques	3	3	45	10	40
	Core VI	BC-366	Toxicology	3	3	45	10	40
SEC	Skill Based	BC-360	Introductory Bioinformatics	2	2	30	10	40
DSC	Core (Practical)	BC-367	Practical course in Techniques in Plant Biotechnology and Molecular Biology-II	2	4 / batch	60	10	40
		BC-368	Practical course in Immunology and Toxicology	2	4 / batch	60	10	40
		BC-369	Practical course in Analytical Biochemistry and Enzymology	2	4 / batch	60	10	40

DSC: Discipline Specific Core Courses/Core Practical; **SEC:** Skill Enhancement Course;
Int : Internal examination; **Ext :** External examination

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T.Y. B.Sc. (Biochemistry): Semester V
Discipline Specific Core (DSC) Course
BC-351: Genetics

Total Hours: 45 **Credits: 3**

Course objectives:

- To accustom students with basic concepts of Genetics.
- To attune students with organization of DNA.
- To study central dogma of genetics.

Course outcomes:

Students will be able to:

- Understand the importance of Mendel's work.
- Understand structure of chromosome and DNA organization.
- Understand replication, transcription, translation processes.
- Understand fine structure of gene, gene regulation and mutations.

Unit-I: Basic Genetics **(11 h)**

- Mendel's law
  - Law of dominance
  - Law of segregation
  - Law of independent assortment
- Incomplete dominance
- Test cross, back cross
- Concept of multiple alleles
  - Characters, symbolism e.g. ABO types
- Lethal gene

Unit-II: Chromosomes & organization of prokaryotic & eukaryotic DNA **(11 h)**

- Morphology, structure and types of chromosome
- Chromosome number and variation in chromosome number
- Structural organization of prokaryotic & eukaryotic DNA
- Central dogma

Unit-III: DNA replication and transcription in bacteria **(12 h)**

- DNA replication in *E. coli*
  - Replication origin, unwinding of the strand, Template DNA, RNA primer, polymerization, replication fork, leading strand, lagging strand, Okazaki fragment
- Transcription components
  - Template, activated precursors, divalent metal ions, RNA polymerase, sigma factor
  - Transcription process-initiation, elongation, termination
- Fine structure of gene
  - Cistron, muton, recon, intron, promotor, repressor, exon, regulator, operator etc
- Gene regulation
  - Operon concept, *lac* operon

Unit-IV: Prokaryotic Translation and Mutations **(11 h)**

- Activation and transfer of amino acids to tRNA
- Translation-initiation, elongation, termination
- Post translational modification in eukaryotes
- Mutations- definition
- Gene mutations
    - Base pair substitutions- transition, transversion and inversion
    - Frameshift mutations- deletion and insertion
    - Missense mutation, nonsense mutations
    - Mutations in termination codons
    - Silent mutations
- Mutagens: definition
    - Chemical-base analogues, agents modifying purines and pyrimidines
    - Physical radiations

References:

- Berg J. M., Tymoczko J. L., Gatto Jr. G. J., Stryer L. (2015), Biochemistry, 8th edition, W. H. Freeman and Company, New York.
- Krebs J. E., Goldstein E. S., Kilpatrick S. T. (2018), Lewin's Genes XII, Jones and Barlett Learning.
- Gardner M., Simmons J., Snustad D. P. (2006), Principle of Genetics, 8th edition, John Willey and Sons.
- Strickberger M.W. (2015), Genetics, 3rd edition, Pearson, India.
- Gupta P.K. (2009), Genetics, Rastogi publication, Meerut.
- Satyanarayana U. (2008), Biotechnology, Books and Allied (P) Ltd, Kolkata.
- Agarwal G. R., Agarwal K., Agarwal O. P. (2014), Textbook of Biochemistry, Goel Publishing House, Meerut
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- Powar C.B. (2007), Genetics Vol. I, Himalaya Publishing House, Mumbai
- Powar C.B. (2009), Genetics Vol. II, Himalaya Publishing House, Mumbai

Methods of Teaching:

- Classroom teaching, Lecture method, ICT enabled teaching

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T.Y. B.Sc. (Biochemistry): Semester V
Discipline Specific Core (DSC) Course
BC-352: Plant Biochemistry and Bio-fertilizers

Total Hours: 45 **Credits: 3**

Course objectives:

- To accustom students with basics of Plant Biochemistry.
- To study the life processes of plants.
- To generate awareness about importance of biofertilizers.

Course outcomes:

Students will be able to:

- Learn life processes like photosynthesis, photorespiration and energy generation.
- Study various phytohormones, secondary metabolites and their mechanism.
- Understand importance of biofertilizers.

Unit-I: Photosynthesis, Photorespiration and ATP generation **(12 h)**

- Definition of photosynthesis, Ultra structure of chloroplast
- Chemistry of Chlorophyll
- Mechanism of Photosynthesis
  - Photosystem I and II
  - Light (Hill) reaction: Cyclic and non-cyclic photophosphorylation
  - Dark reaction: C3 and C4 pathways
  - Kranz anatomy
  - Significance of photosynthesis
  - Factors affecting photosynthesis-external and internal
- Photorespiration:
  - Definition
  - Metabolism of Photorespiration
  - Significance of photorespiration
- Electron transport chain:
  - Components of ETC
  - Oxidative phosphorylation
  - Redox potential and sites of ATP synthesis

Unit-II: Phytohormones **(11 h)**

- Definition and types of phytohormones
- Mechanism of action, physiological effect and applications of
  - Auxins
  - Cytokinins
  - Gibberellins
  - Abscisic acid
  - Ethylene
- Seed dormancy and seed germination

Unit-III: Secondary Metabolites **(11 h)**

- Introduction and biosynthetic pathway of secondary metabolites

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- Classification of Isoprenoid /terpenoids: classification, chemistry, distribution and role of isoprenoids
    - Nitrogen containing secondary plant products: Classification
        - Alkaloids: chemistry distribution classification and physiological role
        - Cyanogenic glycosides and Glucosinolates: chemistry and functions
        - Non-protein amino acids: chemistry and functions
    - Plant phenolics: chemistry, biological functions, classification
        - Chemistry and functions of lignin, flavonoids and tannins

Unit-IV: Biofertilizers **(11 h)**

- Biological nitrogen fixation
    - Nitrogen cycle
    - Symbiotic and asymbiotic nitrogen fixation
    - Mechanism of nitrogen fixation
- Genetic engineering- nitrogenase and hydrogenase gene
- Biofertilizers
    - Symbiotic nitrogen fixer
    - Asymbiotic nitrogen fixer
    - Phosphate solubilising bacteria
    - Organic fertilizers
    - Benefits and limitations of biofertilizers
- Composting –mixed culture composting, vermicomposting

References:

- Gupta N. K., Gupta S. (2005), Plant physiology, Oxford and IBH publishing Co. Pvt. Ltd., New Delhi.
- Devlin R. M., Witham F. H. (1983), Plant Physiology, 4th edition, CBS Pub. New Delhi.
- Salisbary and Ross (2006), Plant physiology, 3rd edition, CBS Pub. New Delhi.
- Verma S. K., Verma M. (1995), A Textbook of Plant Physiology, Biochemistry and Biotechnology, S. Chan and company ltd, New Delhi.
- Satyanarayana U. (2008), Biotechnology, Books and Allied (P) Ltd, Kolkata.
- Jain V. K. (1983), Fundamentals of Plant Physiology, 3rd edition, S. Chan and company ltd, New Delhi
- Chawla H.S. (2009), Introduction to Plant Biotechnology, 3rd edition, CRC press.

Methods of Teaching:

- Classroom teaching, Lecture method, ICT enabled teaching

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T.Y. B.Sc. (Biochemistry): Semester V
Discipline Specific Core (DSC) Course
BC-353: Clinical Biochemistry

Total Hours: 45 **Credits: 3**

Course objectives:

- To accustom students with Biochemistry of various diseases.
- To attune students with inborn errors of metabolism.
- To generate awareness about clinical significance of marker enzymes.

Course outcomes:

Students will be able to:

- Learn various disorders related to carbohydrate metabolism.
- Study different hemoglobinopathies.
- Understand clinical importance of various enzymes and isoenzymes.
- Learn concept of inborn errors of metabolism.

Unit-I: Disorders related to Carbohydrate metabolism **(12 h)**

- Regulation of blood glucose level
  - supply of glucose to the blood and removal glucose from blood
  - Post absorptive state
  - Postprandial state
  - Fundamental regulatory mechanism
  - Hormonal influence on carbohydrate metabolism
- Blood sugar level and its clinical significance
  - Normal values of blood glucose level
  - Causes of hyperglycemia and hypoglycaemia
- Glycosuria: mechanism, types-hyperglycemic glycosuria and renal glycosuria and their subtypes
- Diabetes Mellitus: Definition, stages of diabetes mellitus, clinical types and causes, metabolic changes and complications, effect of insulin on carbohydrate, lipid and protein metabolism

Unit-II: Hemoglobinopathies **(11 h)**

- Structure and functions of hemoglobin
- Abnormal hemoglobins: types based on mutation in structural gene and mutation in regulator gene
  - Sickle cell anaemia
  - Methemoglobinemia-Hb-M, Hb-Sabine
  - High O_2-affinity hemoglobins-Hb-Chesapeake, Hb-Rainier
  - Hemoglobin interfere in mRNA formation-Hb-Constant spring
  - Thalassemia

Unit-III: Enzymes and isoenzymes of clinical importance **(11 h)**

- General consideration
- Serum enzymes in heart diseases
- Serum enzymes in liver diseases
- Serum enzymes in GI tract diseases

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- Serum enzymes in muscle diseases
- Serum enzymes in bone diseases
- Isoenzymes: definition, clinical significance of LDH and CPK isoenzymes

Unit-IV: Inborn Errors of Metabolism **(11 h)**

- Carbohydrate metabolism disorders
  - Lactose intolerance
  - Glycogen storage disease
  - Galactosemia
- Protein metabolism disorders
  - Phenylketonuria
  - Alkaptonuria
  - Albinism
  - Maple syrup urine disease
- Lipids metabolism disorders
  - Gaucher's disease
  - Nieman Pick's disease
  - Tay Sachs disease
- Nucleic acid metabolism disorders
  - Lesch Nyhan syndrome
  - Gout

References:

- Chatterjee M. N., Shinde R. (2012) Textbook of Medical Biochemistry, 8th edition, Jaypee Brothers Medical Publishers (P) Ltd, New Delhi
- Dua A., Mahajan R. (2018) Clinical Biochemistry, Jnanda Prakashan, Delhi
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- Sanyal S., Bhattacharyya A. (2012), Clinical Pathology-A Practical Manual, 3rd edition, Elsevier, India.
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- Talwar G. P. (2002), Textbook of Human Biochemistry, 3rd edition, Prentice Hall India Learning Pvt. Ltd.
- Chatterjee C. C. (2018), Human Physiology Vol I and II, 12th edition, CBS.

Methods of Teaching:

- Classroom teaching, Lecture method, ICT enabled teaching

HEAD
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T.Y. B.Sc. (Biochemistry): Semester V
Discipline Specific Core (DSC) Course
BC-354: Metabolism

Total Hours: 45 **Credits: 3**

Course objectives:

- To accustom students with basics of metabolism.
- To comprehend catabolism and anabolism of various metabolites.
- To aware students about regulation of metabolic reactions.

Course outcomes:

Students will be able to:

- Learn various catabolic and anabolic reactions related to carbohydrate and amino acids.
- Study lipid and nucleotide metabolic reactions.
- Understand importance of metabolism in living things.

Unit-I: Carbohydrate metabolism **(12 h)**

- Glycolysis: steps; balance sheet; bioenergetics; fate of pyruvate
- Tricarboxylic acid cycle: oxidation of pyruvate to acetyl Co-A; steps of TCA cycle; balance sheet; bioenergetics
- Glyoxylate cycle
- HMP pathway: functions of HMP pathway; steps
- Glycogenolysis: steps of conversion of glycogen to glucose under the influence of epinephrine and glucagon
- Gluconeogenesis: from pyruvate and amino acids
- Glycogen biosynthesis

Unit-II: Amino acids metabolism **(11 h)**

- Proteolysis: digestion of proteins; enzymes involved in digestion of protein
- Transamination: Transamination of L-aspartate, L-alanine, L-leucine, and L-tyrosine; mechanism of the reaction
- Oxidative deamination: general reaction; oxidative deamination of glutamate
- Transmethylation: mechanism of transmethylation involving methionine as methyl group donor
- Decarboxylation: general reaction; decarboxylation of histidine, tryptophan and arginine
- Nitrogen excretory products:
    - Synthetic pathway
    - Glutamine pathway
    - Direction excretion
    - Creatine and Creatinine
    - Urea cycle

Unit-III: Lipid metabolism **(11 h)**

- Activation of fatty acids and transportation into mitochondria
- β-oxidation of saturated even carbon fatty acids: steps, balance sheet, bioenergetics

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- β-oxidation of saturated odd carbon fatty acids: steps, fate of propionyl Co-A
- β-oxidation of unsaturated fatty acids: fatty acids having one and two double bonds
- Biosynthesis of fatty acids: formation of malonyl Co-A; enzymes and functions of fatty acid synthetase complex; steps of fatty acid biosynthesis
- Elongation of saturated fatty acid and desaturation of fatty acids

Unit-IV: Nucleotides metabolism **(11 h)**

- Biosynthesis of purine ribonucleotides: steps of AMP and GMP biosynthesis
- Regulation of purine nucleotide biosynthesis
- Biosynthesis of pyrimidine ribonucleotide: steps of UMP and CMP biosynthesis
- Regulation of pyrimidine biosynthesis
- Biosynthesis of Deoxyribonucleotides: conversion of ribose sugar to 2'deoxyribose sugar
- Formation of deoxythymidylic acid: steps
- Regulation of deoxyribonucleotide biosynthesis
- Degradation of purines
- Salvage of purines
- Purine nucleotide cycle
- Pyrimidine degradation

References:

- Nelson D. L., Cox M. M. (2013), Lehninger Principles of Biochemistry, 6th edition, W. H. Freeman and Company, New York.
- Berg J. M., Tymoczko J. L., Gatto Jr. G. J., Stryer L.(2015), Biochemistry, 8th edition, W. H. Freeman and Company, New York.
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- Powar C. B. (2010), Cell Biology, Himalaya Publishing House, Mumbai
- Powar C. B., Chatwal G. R. (2011), Biochemistry, Himalaya Publishing House, Mumbai

Methods of Teaching:

- Classroom teaching, Lecture method, ICT enabled teaching

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T.Y. B.Sc. (Biochemistry): Semester V
Discipline Specific Core (DSC) Course
BC-355: Biophysical Chemistry

Total Hours: 45 **Credits: 3**

Course objectives:

- To study various biophysical processes.
- To understand the significance of biophysical processes.
- To study laws of thermodynamics and bioenergetics.

Course outcomes:

Students will be able to:

- Understand the concept of acid-base and buffers.
- Study various biophysical processes like diffusion, osmosis, viscosity, etc.
- Learn energy rich compounds, bioenergetics and laws of thermodynamics.

Unit-I: Acids and Bases **(11 h)**

- Properties of water in relation to life process
  - Expansion on freezing
  - Uniquely high surface tension
  - Uniquely high heat capacity
  - High solvent power
- Concept of Acid and Base
  - Arrhenius theory
  - Lewis acid and base
  - Lowry-Bronsted Theory
- Acid-Base equilibria in water
  - Law of Mass Action
  - Ionisation of water
  - Equilibrium constant and Ionisation constant of water
  - Concept of pH
- Buffers-Concept and definition
  - Henderson-Hasselbalch equation
- Biological buffer systems
  - Phosphate buffer system
  - Bicarbonate buffer system

Unit-II: Diffusion, Osmosis and Colloidal phenomena **(12 h)**

- Diffusion-definition and types
  - Fick's laws of diffusion-first and second
  - Methods of determination of diffusion coefficient
  - Significance of diffusion coefficient
- Osmosis-definition
  - Osmotic pressure- definition and its measurement
  - Tonicity-types
  - Significance of osmosis in biology
- Colloids-concept
  - Classification of colloids-lyophilic and lyophobic colloids

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- Brownian movement
- Tyndall effect
- Donnan membrane equilibrium

Unit-III: Viscosity, Surface tension and Adsorption **(11 h)**

- Viscosity-concept
  - Factors affecting viscosity
  - Measurement of viscosity
    - Capillary flow
    - Rotation of a cylinder immersed in solution
    - Rate of fall of a ball through solution
  - Applications of viscometry
  - Significance of viscosity in biological systems
- Surface tension-concept
  - Factors affecting surface tension
  - Measurement of surface tension
- Adsorption- concept
  - Kinds of adsorption interactions
  - Characteristics of adsorption
  - Importance of adsorption phenomena

Unit-IV: Bioenergetics **(11 h)**

- Energy, Free energy and Energetic coupling
- Energy rich compounds
  - ATP, causes of energy richness of ATP
  - Other energy rich compounds
- Thermodynamics-definition
  - First and second law of thermodynamics
  - Enthalpy
  - Entropy
  - Standard free energy change
  - Exergonic and endergonic reactions
- Redox potential and its measurement

References:

- Frifielder D. (1983), Physical Biochemistry, W. H. Freeman and Co. New York.
- Holmes D. J., Peck H. (1983), Analytical biochemistry, academic press, N. Y.
- Upadhyay A., Upadhyay K., Nath N. (2016), Biophysical chemistry: Principle and technique, Himalaya Pub. Nagpur.
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- Roy R.N. (2001), A Textbook of Biophysics, New Central Book agency (P) Ltd.

Methods of Teaching:

- Classroom teaching, Lecture method, ICT enabled teaching

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T.Y. B.Sc. (Biochemistry): Semester V
Discipline Specific Core (DSC) Course
BC-356: Fermentation Technology

Total Hours: 45 **Credits: 3**

Course objectives:

- To accustom students with basics of Fermentation Technology.
- To attune students with bioreactors and downstream processing.
- To explore industrial applications of fermentation.

Course outcomes:

Students will be able to:

- Learn screening of microbes, their preservation and inoculum development.
- Understand instrumentation, types and working of bioreactors.
- Study the basics of downstream processing.

Unit-I: Basics of Fermentation Technology **(11 h)**

- Fermentation: definition and concept
- Characteristic of industrial strain
- Screening of industrially important microbes: Primary & Secondary
- Fermentation media: Composition, Raw materials, screening of media, antifoam, buffer.
- Inoculum –stock, working culture
- Inoculum development
- Preservation methods for industrially important microbes

Unit-II: Bioreactors **(12 h)**

- History of Bioreactors
- Parts of Bioreactors and their functions
    - Materials of construction
    - Valves
    - Agitators and its types
    - Sparger
    - Port feeders
    - Baffles
- Controlling system
- Types of bioreactors
    - Primary bioreactor
    - Tower
    - Air lift
    - Deep jet
- Conventional Bioreactor-common features
- Operation of conventional bioreactor

Unit-III: Types of fermentation and Downstream processing **(11 h)**

- Types of fermentation
    - Submerged
    - Solid state

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- Batch fermentation
- Continuous fermentation:
  - Chemostat
  - Turbidostat
- Synchronous culture and its applications.
- Introduction to downstream processing
  - Solid-liquid separation
  - Release of intracellular products by cell disruption
  - Concentration
  - Purification by chromatography
  - Formulation
  - Drying

Unit-IV: Industrial Biotechnology **(11 h)**

- Industrial sterilization process –
  - Concept and need of sterilization
  - History of sterilization
  - Types of sterilization:
    - Batch
    - Continuous
    - Filtration
- Industrial production of –
  - Enzymes- amylase
  - Acid- citric acid
  - Alcohol- ethanol
  - Antibiotic- penicillin
- Microbial biomass production
  - Introduction
  - Yeast
  - Economic aspect and Applications
- Bioconversion
  - Introduction
  - Biomining and bioleaching- copper

References:

- Patel A. H. (1984), Industrial Microbiology, MacMillan India Ltd, New Delhi
- Verma S. K., Verma M. (1995), A Textbook of Plant Physiology, Biochemistry and Biotechnology, S. Chan and company ltd, New Delhi.
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Methods of Teaching:

- Classroom teaching, Lecture method, ICT enabled teaching

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T.Y. B.Sc. (Biochemistry): Semester V
Skill Enhancement Course (SEC)
BC-350: Introductory Biostatistics

Total Hours: 30 **Credits: 2**

Course objectives:

- To accustom students with concept of biostatistics.
- To aware students about applications of biostatistical methods.

Course outcomes:

Students will be able to:

- Understand basic terms in biostatistics.
- Represent data diagrammatically and graphically.
- Solve problems based on mean, mode and median.

Unit-I: Introduction to Biostatistics and Diagrammatic representation of data (15 h)

- Biostatistics: definition and application
- Basic terms: Data- classification of data; Variables- discrete and continuous, variate, derived variables- ratio index and rates; Constant; Population and sample; Tabulation; Frequency table- relative and cumulative frequency distribution
- Sampling: concept, size of sample, types of sampling
- Diagrammatic representation of data: line diagram; bar diagram- simple, divided, percentage, multiple; Pie diagram, pictogram
- Significance and limitations of diagrammatic representation
- Graphical representation of data: Histogram, Frequency polygon, Frequency curve, Cumulative frequency curve
- Significance and limitations of graphic representation

Unit-II: Central tendency and Probability (15 h)

- Measures of central tendency : definition, functions and properties
- Arithmetic mean: Calculation of mean in a series of individual observations, discrete, continuous; merits and demerits of mean
- Median: Calculation of median in a series of individual observations, discrete, continuous; merits and demerits of mean
- Mode: Calculation of mode in a series of individual observations, discrete, continuous; merits and demerits of mean
- Relationship between mean, median and mode
- Probability: definition, basic terms- random experiment or trial, event, permutation and combination
- Theorems of probability: addition rule and multiplication rule
- Probability distribution: Binomial, Poisson and normal
- Concept of multivariate statistics

References:

- Le C. T., Eberly L. E., (2016), Introductory Biostatistics, 2nd edition, Wiley, USA.
- Motulsky H., (2010), Intuitive Biostatistics, 2nd edition, Oxford University Press, UK.
- Rosner B., (2016), Fundamentals of Biostatistics, 8th edition, Cengage Learning, USA.

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- Arora P.N., Malhan P.K. (2008), Biostatics, latest edition, Himalaya publishing house, Nagpur.
- Khan I.A. and Khanum A. (2008), Fundamentals of Biostastistics, 3rd edition, Ukaaz-Publication, Hyderabad.
- Jin Xiong, (2007), Essentials of Bioinformatics, first edition, Cambridge university press, USA.
- Daniel W.W., (2006), Biostatistics, 7th edition, Wiley Dreamtech India (P) Ltd, New Delhi

Methods of Teaching:

- Classroom teaching, Lecture method, ICT enabled teaching

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T.Y. B.Sc. (Biochemistry): Semester V
Discipline Specific Core (DSC) Course
BC-357: Practical course in Techniques in Plant Biotechnology & Molecular Biology-I

Total Hours: 60 **Credits: 2**

Course objectives:

- To accustom students with Techniques in Molecular Biology.
- To attune students with microbial screening and isolation techniques.
- To study techniques in Plant Biotechnology.

Course outcomes:

Students will be able to:

- Isolate DNA and estimate DNA, RNA, secondary metabolite & chlorophyll pigments.
- Produce alcohol and amylase.
- Screen phosphate solubilizing bacteria and nitrogen fixing bacteria.

Sr. No.	Topic Particular	Hours
1	Isolation of DNA from suitable sample.	04
2	Estimation of DNA by DPA method.	04
3	Estimation of RNA by orcinol method.	04
4	Estimation of chlorophyll pigments by spectrophotometric method.	04
5	Estimation of any one secondary metabolite.	04
6	Determination of activity of Phosphate solubilizing bacteria.	04
7	Isolation of nitrogen fixing bacteria from root nodules.	04
8	Isolation of nitrogen fixing bacteria from soil sample.	04
9	Preparation of manure by vermicomposting process.	04
10	Production of alcohol.	04
11	Production of amylase.	04
12	Production of citric acid	04
13	Separation of plant pigments by chromatography.	04
14	Demonstration of working of fermenter.	04
15	Solve the problems based on Mendel's experiments.	04

***Mandatory to perform any 12 practical from above.**

References:

- Sadasivam S., Manikam A. (2018), Biochemical Methods, 3rd edition, New Age International Pvt. Ltd.
- Aneja K. R. (2003), Experiments in Microbiology, Plant Pathology and Biotechnology, New Age International Pvt. Ltd.
- Sawhney S.K., Singh R. (2001), Introductory Practical Biochemistry, Narosa Publishing House, New Delhi
- Plummer D. (2017), An Introduction to Practical Biochemistry, Indian Edition, McGraw Hill Education.
- Jayaraman J. (1996), Laboratory manual in Biochemistry, Wiley Eastern Ltd.

Methods of Teaching:

- Laboratory method, Lecture cum demonstration methods

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M.J.COLLEGE(AUTONOMOUS)JALGAON

T.Y. B.Sc. (Biochemistry): Semester V
Discipline Specific Core (DSC) Course
BC-358: Practical course in Clinical Biochemistry

Total Hours: 60 **Credits: 2**

Course objectives:

- To accustom students with various pathological tests.
- To generate awareness about clinical significance of the tests.

Course outcomes:

Students will be able to:

- Estimate various clinically important components with their clinical significance.
- Estimate various clinically important enzymes and their clinical significance.
- Correlate results obtained clinically.

Sr. No.	Topic Particular	Hours
1	Estimation of blood glucose by suitable method.	04
2	Estimation of reducing sugar in urine.	04
3	Hb estimation by using haematometer and its significance.	04
4	Estimation of serum bilirubin.	04
5	Estimation of SGOT by 2, 4 DNPH method.	04
6	Estimation of SGPT by 2, 4 DNPH method.	04
7	Serum alkaline phosphatase estimation by colorimetric method.	04
8	Serum acid phosphatase estimation by colorimetric method.	04
9	Estimation of cholesterol by colorimetric method.	04
10	Estimation of serum uric acid from the given sample.	04
11	Estimation of serum urea from the given sample.	04
12	Estimation of serum creatinine from the given sample.	04
13	Detection of abnormal constituents of urine: Sugar, protein, ketone bodies and bile pigments.	04
14	Estimation of proteins by Biuret method.	04
15	Estimation of serum calcium from given sample.	04

***Mandatory to perform any 12 practical from above.**

References:

- Sharma S., Sharma R. (2016), Practical manual of Biochemistry, Scientific International Publisher and Distributor, New Delhi.
- Maheshwari N. (2008), Clinical Biochemistry, Jaypee Brothers, Medical Publishers.
- Godkar P. B., Godkar D. P., Textbook of medical laboratory technology, 2nd edition, Bhalani Publishing House, Mumbai
- Sadasivam S., Manickam A. (2018), Biochemical Methods, 3rd edition, New Age International Pvt. Ltd.
- Sawhney S. K., Singh R. (2001), Introductory Practical Biochemistry, Narosa Publishing House, New Delhi

Methods of Teaching:

- Laboratory method, Lecture cum demonstration methods

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M.J.COLLEGE (AUTONOMOUS) JALGAON

T.Y. B.Sc. (Biochemistry): Semester V
Discipline Specific Core (DSC) Course
BC-359: Practical course in Biophysical Chemistry

Total Hours: 60 **Credits: 2**

Course objectives:

- To accustom students with practical applications of biophysical chemistry.
- To give practical experience of biophysical processes.
- To aware students about significance of biophysical processes.

Course outcomes:

Students will be able to:

- Prepare buffers of desirable pH and molarity.
- Determine viscosity and surface tension of the sample.
- Practical experience of the processes like diffusion and osmosis.

Sr. No.	Topic Particular	Hours
1	Preparation of phosphate buffer of suitable pH and molarity.	04
2	Determination of viscosity of suitable liquid by viscometer.	04
3	Measurement of surface tension of the given sample.	04
4	Estimation of λ_{max} and extinction coefficient of a given chromophore.	04
5	Quantitative estimation of protein by lowery's method.	04
6	Protein precipitation by ammonium sulfate salt.	04
7	Purification of precipitated protein by dialysis method.	04
8	Isolation and estimation of casein from milk by isoelectric precipitation.	04
9	Calculation of the isoelectric point of a protein (solve given problems).	04
10	Determination of diffusion of the sugar across semipermeable membrane.	04
11	To study cell membrane permeability using beetroot.	04
12	To study the effect of temperature on permeability of beetroot membrane.	04
13	To study the effect of pH on permeability of beetroot membrane.	04
14	Preparation of RBC ghost cells and to study the effect of different solutes on permeability of RBC membrane.	04
15	Separation of carbohydrates by TLC.	04

***Mandatory to perform any 12 practical from above.**

References:

- Sadasivam S., Manikam A. (2018), Biochemical Methods, 3rd edition, New Age International Pvt. Ltd.
- Sawhney S. K., Singh R. (2001), Introductory Practical Biochemistry, Narosa Publishing House, New Delhi
- Plummer D. (2017), An Introduction to Practical Biochemistry, Indian Edition, McGraw Hill Education.
- Giese A. C. (1975), Laboratory manual in cell physiology, Boxwood press, CA.
- Von Blum Ruth (1981), Experimental studies of permeability in red blood cells. In tested studies for laboratory teaching (Glase, Jon C., Ed.) Kendall/Hunt Pub. Co.

Methods of Teaching:

- Laboratory method, Lecture cum demonstration methods

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T.Y. B.Sc. (Biochemistry): Semester VI
Discipline Specific Core (DSC) Course
BC-361: Genetic Engineering

Total Hours: 45 **Credits: 3**

Course objectives:

- To introduce students to the genetic engineering field.
- To make students aware about various genetic engineering techniques.
- To appraise students about applications of genetic engineering.

Course outcomes:

Students will be able to:

- Learn role of enzymes and vectors involved in gene transfer.
- Study various gene transfer methods.
- Study gene library preparation.
- Understand the basic principles of DNA sequencing and PCR.

Unit-I: Introduction to Genetic Engineering **(11 h)**

- Concepts of Genetic engineering
- Enzymes involved in genetic engineering- restriction endonucleases, DNA ligases, Alkaline phosphatases, DNA modifying enzymes
- Prokaryotic and eukaryotic cells as hosts

Unit-II: Vectors and methods of gene transfer **(12 h)**

- Vectors- Plasmids, Bacteriophages, Cosmids, Artificial chromosome vectors, Shuttle vectors
- Construction of rDNA- palindromes and staggered cleavage adding poly dA and poly dT tails, blunt end ligation
- Methods of gene transfer- transformation, conjugation, Electroporation, Liposome mediated gene transfer, transduction, direct transfer of DNA, particle bombardment, microinjection, polyethylene glycol mediated gene transfer

Unit-III: Gene Libraries **(11 h)**

- Concept of gene libraries
- Creation of human gene library, Use of long chain PCR for gene library construction
- cDNA libraries- cDNA synthesis, construction of cDNA libraries, RT-PCR for cDNA libraries
- Screening Strategies- screening by DNA hybridization, DNA probes, colony hybridization, PCR, immunological assay, protein function

Unit-IV: Techniques in Genetic Engineering **(11 h)**

- DNA Sequencing: Technique, applications, limitations of
  - Maxam Gilbert technique
  - Sanger's Dideoxynucleotide method
  - Pyrosequencing
  - DNA chip

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- Polymerase Chain Reaction: principle, technique, applications of PCR in various fields

References:

- Berg J. M., Tymoczko J. L., Gatto Jr. G. J., Stryer L. (2015), Biochemistry, 8th edition, W. H. Freeman and Company, New York.
- Krebs J. E., Goldstein E. S., Kilpatrick S. T. (2018), Lewin's Genes XII, Jones and Barlett Learning.
- Gardner M., Simmons J., Snustad D. P. (2006), Principle of Genetics, 8th edition, John Willey and Sons.
- Strickberger M.W. (2015), Genetics, 3rd edition, Pearson, India.
- Gupta P.K. (2009), Genetics, Rastogi publication, Meerut.
- Satyanarayana U. (2008), Biotechnology, Books and Allied (P) Ltd, Kolkata.
- Agarwal G. R., Agarwal K., Agarwal O. P. (2014), Textbook of Biochemistry, Goel Publishing House, Meerut
- Powar C.B. (2010), Cell Biology, Himalaya Publishing House, Mumbai
- Powar C.B. (2007), Genetics Vol. I, Himalaya Publishing House, Mumbai
- Powar C.B. (2009), Genetics Vol. II, Himalaya Publishing House, Mumbai

Methods of Teaching:

- Classroom teaching, Lecture method, ICT enabled teaching

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T.Y. B.Sc. (Biochemistry): Semester VI
Discipline Specific Core (DSC) Course
BC-362: Plant Biotechnology and Biomembranes

Total Hours: 45 **Credits: 3**

Course objectives:

- To accustom students with plant tissue culture techniques.
- To study the role of membranes in biological systems.
- To appraise students about importance of PTC techniques and Biomembranes.

Course outcomes:

Students will be able to:

- Learn various plant tissue culture techniques.
- Understand Agrobacterium mediated gene transfer.
- Explain mechanism of membrane transport and cell signaling.

Unit-I: Plant Tissue Culture **(08 h)**

- Introduction to PTC
- Culture media composition
- Terms used in PTC
- Basic technique of plant tissue culture
- Applications of PTC
- Types of cultures-Callus culture, Cell culture
- Protoplast isolation, fusion and culture

Unit-II: Micropropagation and Genetic Engineering of Plants **(10 h)**

- Micropropagation:
  - Definition and technique
  - Multiplication by axillary buds and apical shoots- meristem, shoot tip cultures and bud cultures
  - Organogenesis-direct and indirect
  - Somatic embryogenesis-direct and indirect
  - Factors affecting
  - Applications and disadvantages
- Agrobacterium mediated gene transfer
  - Organisation of Ti plasmid
  - T-DNA transfer and integration
  - Ti plasmid derived vector systems
  - Plant transformation techniques using Agrobacterium
  - Advantages and limitation of Agrobacterium mediated gene transfer

Unit-III: Membrane structure and transport **(15 h)**

- Plasma Membrane structure: Fluid Mosaic model
- Solute Transport across Membranes:
  - Mechanisms: Passive diffusion, Facilitated diffusion (carrier proteins and channels- ligand-gated channels and voltage-gated channels), Active transport (primary and secondary active transport, group translocation)
- Transport systems: Uniport system, Symport system and Antiport system

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- Transport of glucose to the erythrocytes
- Neuronal Na^+ channel
- Acetylcholine receptor
- Primary active transport- P-type ATPase (Na^+-K^+ pump)
- Secondary active transport- Ion gradients provide the energy for secondary active transport, lactose transporter
- Group translocation: phosphotransferase system
- Exocytosis: role of proteins, constitutive and regulated exocytosis, neurotransmitter release
- Endocytosis: role of proteins, pinocytosis, phagocytosis, Receptor-mediated endocytosis- Cholesteryl esters enter cells
- Aquaporins

Unit-IV: Membrane receptors and Cell signaling **(12 h)**

- Cell signaling/signal transduction: Introduction and definition
- Stages of cell signaling: Reception, transduction and response
- General features of signal transduction: Specificity and sensitivity, Modularity, Desensitization and Integration
- Types of receptors:
    - G protein–coupled receptors, Receptor tyrosine kinases, Receptor guanylyl cyclases, Gated ion channels, Adhesion receptors and Nuclear receptors
- Secondary messengers: Diacylglycerol, Inositol Trisphosphate, and Ca^{2+}
- Signaling in microorganisms: two component signaling mechanism
- Signaling in plants: Transduction mechanism for detection of ethylene by plants

References:

- Gupta P. K. (2005), Elements of Biotechnology, Rastogi Publication Meerut.
- Ignacimuthu S. (1997), Applied plant biotechnology, Science Publishers, U.S.
- Ramavat K. G. (2008), Plant biotechnology, S. Chand and Co., New Delhi.
- Satyanarayana U. (2008), Biotechnology, Books and Allied (P) Ltd, Kolkata.
- Chawla H.S. (2009), Introduction to Plant Biotechnology, 3rd edition, CRC press.
- Jogdand S.N. (2012), Advances in Biotechnology, Himalaya Publishing House, Mumbai.
- Nelson D. L., Cox M. M. (2013), Lehninger Principles of Biochemistry, 6th edition, W. H. Freeman and Company, New York.
- Berg J. M., Tymoczko J. L., Gatto Jr. G. J., Stryer L.(2015), Biochemistry, 8th edition, W. H. Freeman and Company, New York.
- Satynarayana U., Chakrapani U. (2017), Textbook of Biochemistry, 5th edition, Elsevier, India.

Methods of Teaching:

- Classroom teaching, Lecture method, ICT enabled teaching

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T.Y. B.Sc. (Biochemistry): Semester VI
Discipline Specific Core (DSC) Course
BC-363: Immunology

Total Hours: 45 **Credits: 3**

Course objectives:

- To accustom students with basics of immunology.
- To comprehend various immunochemical tests.
- To aware students about importance and role of immune system.

Course outcomes:

Students will be able to:

- Explore cells and organs of immune system.
- Learn immunity and immune response.
- Study concept of antigen and antibody.
- Understand the importance of immunochemistry in diagnosis.

Unit-I: Cells and organs of immune system **(12 h)**

- Hematopoiesis
- Cells of immune system
  - Lymphoid cells- T-cells, B-cells, Natural killer cells, dendritic cells
  - Granulocytes- Neutrophils, Eosinophils, Basophils, Monocytes, Macrophages, Mast cells
- Organs of immune system
  - Primary lymphoid organs
    - Thymus
    - Bone marrow
    - Lymphatic system
  - Secondary lymphoid organs
    - Lymph nodes
    - Spleen
    - MALT and GALT

Unit-II: Immunity and Immune response **(11 h)**

- Immunity- definition and types
- Innate immunity
  - Factors influencing innate immunity
  - Mechanism of innate immunity
  - Cellular factor in innate immunity
- Adaptive/ acquired immunity
  - Active and passive immunity
- Immune response
  - Humoral immune response
    - Primary and secondary immune response
    - Antibody production
    - Factors affecting antibody production
  - Cell mediated immune response

HEAD
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Unit-III: Antigen and Antibody **(11 h)**

- Antigen-
  - Definition
  - Basic terms- hapten, adjuvants, epitopes
  - Antigenicity and immunogenicity
  - Determinants of an antigenicity
- Basic structure of antibody
  - Classes of antibodies
    - IgG, IgA, IgM, IgD, IgE- structure and functions
  - Antigenic determinants on immunoglobulins
    - Isotype, Allotype and Idiotype

Unit-IV: Immunochemistry **(11 h)**

- General features of antigen-antibody reactions
- Precipitation reaction- mechanism and applications
  - Flocculation reaction
  - Single diffusion
  - Double diffusion
  - Radial immunodiffusion
  - Immunoelectrophoresis
  - Crossover immunoelectrophoresis
  - Rocket immunoelectrophoresis
- Agglutination reaction
  - Slide and tube agglutination
  - Coombs test and passive agglutination
- Immunofluorescence
- Radioimmunoassay
- ELISA- types

References:

- Shastri N.V. (2005), Principles of Immunology, Himalaya Publishing House, Mumbai
- Kindt T. J., Goldsby R. A., Osborne B. A. (2006), Kuby Immunology, 6th edition, W.H. Freeman and Company, New York
- Kanungo R. (2017), Ananthanarayan and Panikar's Textbook of Microbiology, 10th edition, The Orient Blackswan.
- Delves P. J., Martin S. J., Burton D. R. (2011), Roitt's Essential Immunology, 12th edition, Willey-Blackwell.
- Tizard I. (2005), Immunology: An Introduction, Cengage Learning (RS).

Methods of Teaching:

- Classroom teaching, Lecture method, ICT enabled teaching

HEAD
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T.Y. B.Sc. (Biochemistry): Semester VI
Discipline Specific Core (DSC) Course
BC-364: Enzymology

Total Hours: 45 **Credits: 3**

Course objectives:

- To accustom students with basics of enzymology.
- To attune students with mechanism of enzyme action.
- To understand applications enzyme in various fields.

Course outcomes:

Students will be able to:

- Understand classification and specificity of enzymes.
- Learn mechanism of enzyme action and enzyme kinetics.
- Study activation and deactivation of regulatory enzymes.
- Explore various industrial applications of enzymes

Unit-I: Basic concepts in Enzymology **(11 h)**

- Definition of enzyme
- Terminologies - intracellular enzymes, extracellular enzymes, holoenzymes, apoenzymes, prosthetic group, cofactor, coenzymes, isoenzymes, katal, international unit, turnover number and active site.
- Nomenclature and classification (IUB) of enzymes
- Factors affecting enzyme activity - effect of substrate concentration, enzyme concentration, product concentration, pH, temperature, activators, time, light and radiation.
- Specificity of enzyme action - absolute specificity, group specificity, optical specificity and geometrical specificity.
- Active site - definition and salient features of active site.

Unit-II: Enzyme Kinetics and Inhibition **(12 h)**

- Mechanism of enzyme action – lowering of activation energy, lock and key model, induced fit model.
- Michaelis Menten Equation: derivation, Km Vmax
- Transformation of Michaelis –Menten equation: Lineweaver-Burk plot, Eadie-Hofstee plot
- Inhibition: Reversible inhibition- competitive, non-competitive and uncompetitive inhibition with examples.
- Factors contributing to the catalytic efficiency of enzymes: proximity and orientation of the substrate, covalent catalysis, acid-base catalysis, factor of strain in enzyme catalysis

Unit-III: Regulatory enzymes **(11 h)**

- Allosteric enzymes: definition, feedback inhibition, positive and negative modulator, heterotropic and homotropic control, mechanism of regulatory activity of allosteric enzymes- sequential and symmetry model, kinetics of allosteric enzymes, aspartate transcarbamoylase-kinetics and inhibition

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- Covalently modulated enzymes: definition, explanation with example of glycogen phosphorylase enzyme
- Covalent activation of zymogen: pepsinogen, trypsinogen, chymotrypsinogen
- Classes of proteolytic enzymes: serine, aspartate, cysteine and metalloproteases

Unit-IV: Applications of enzymes **(11 h)**

- Enzyme Immobilization: methods
- Applications of immobilized enzymes and cells
    - Manufacture of commercial products
    - Analytical applications
    - Therapeutic applications
- Enzyme based biosensors and their applications
- Other applications of enzymes

References:

- Nelson D. L., Cox M. M. (2013), Lehninger Principles of Biochemistry, 6th edition, W. H. Freeman and Company, New York.
- Berg J. M., Tymoczko J. L., Gatto Jr. G. J., Stryer L.(2015), Biochemistry, 8th edition, W. H. Freeman and Company, New York.
- Satynarayana U., Chakrapani U. (2017), Textbook of Biochemistry, 5th edition, Elsevier, India.
- Talwar G. P. (2002), Textbook of Human Biochemistry, 3rd edition, Prentice Hall India Learning Pvt. Ltd.
- Agarwal G. R., Agarwal K., Agarwal O. P. (2014), Textbook of Biochemistry, Goel Publishing House, Meerut
- Powar C. B. (2010), Cell Biology, Himalaya Publishing House, Mumbai
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Methods of Teaching:

- Classroom teaching, Lecture method, ICT enabled teaching

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T.Y. B.Sc. (Biochemistry): Semester VI
Discipline Specific Core (DSC) Course
BC-365: Analytical Techniques

Total Hours: 45 **Credits: 3**

Course objectives:

- To accustom students with basics of various analytical techniques.
- To familiarize students with working principles of various analytical instruments.
- To explore applications of analytical techniques.

Course outcomes:

Students will be able to:

- Study concept, principle, and applications of various spectrophotometry.
- Learn principles and applications of various chromatography and electrophoretic techniques.
- Understand concept of centrifugation and radioactivity and its applications.

Unit-I:Spectrophotometry **(11 h)**

- Concept of electromagnetic radiations, electromagnetic spectrum
- Laws of absorption- Lambert and Beer Law
- Chromophore concept-auxochrome, various chromic shifts
- Instrumentation for UV-Visible and infra-red spectrophotometry
    - Applications of UV-Vis spectrophotometry
    - Theory and applications of infra-red spectroscopy
- Spectrofluorimetry
    - Fluorescence and phosphorescence
    - Theory and instrumentation of fluorimetry
    - Advantages, disadvantages and applications
- Flame spectrophotometry-concept
    - Instrumentation for emission flame photometry and atomic absorption spectrophotometry
    - Applications of both

Unit-II: Chromatography **(12 h)**

- Concept of distribution coefficient
- Modes of chromatography
- Classification of chromatography
- Principle and applications of-
    - Paper chromatography
    - Thin layer chromatography
    - Gel filtration chromatography
    - Ion exchange chromatography
    - Affinity chromatography
    - Gas liquid chromatography
    - Liquid-liquid chromatography

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M.J.COLLEGE (AUTONOMOUS) JALGAON

Unit-III: Electrophoresis **(11 h)**

- Principle of electrophoresis
- Migration of an ion in an electric field
- Factors affecting electrophoretic mobility
- Principle and applications of-
    - Paper electrophoresis
    - Agarose gel electrophoresis
    - Polyacrylamide gel electrophoresis
    - SDS-Polyacrylamide gel electrophoresis
    - Isoelectric focussing
    - Capillary electrophoresis
    - Immunoelectrophoresis

Unit-IV: Centrifugation and Radioactivity **(11 h)**

- Basic principles of centrifugation
- Instrumentation for centrifugation: low speed, high speed and ultra centrifuges
- Applications of centrifugation: preparative techniques, analytical measurements
- Radioactivity: introduction, isotopes in Biochemistry, units of radioactivity
- Detection and measurement of radioactivity: Liquid Scintillation Counting, Geiger Muller Counting
- Applications of radioisotopes
- Radioisotopes and safety

References:

- Frifielder D. (1983), Physical biochemistry, W. H. Freeman and Co. New York.
- Holmes D. J., Peck H. (1983), Analytical biochemistry, academic press, New York.
- Upadhyay A., Upadhyay K., Nath N. (2016), Biophysical chemistry: Principle and technique, Himalaya Pub. Nagpur.
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- Powar C.B., Chatwal G.R. (2011), Biochemistry, Himalaya Publishing House, Mumbai
- Boyer R. (2002), Modern Experimental Biochemistry, 3rd edition, Pearson Education, Inc.
- Roy R.N. (2001), A Textbook of Biophysics, New Central Book agency (P) Ltd.

Methods of Teaching:

- Classroom teaching, Lecture method, ICT enabled teaching

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DEPARTMENT OF BIOCHEMISTRY
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T.Y. B.Sc. (Biochemistry): Semester VI
Discipline Specific Core (DSC) Course
BC-366: Toxicology

Total Hours: 45 **Credits: 3**

Course objectives:

- To accustom students with basic concepts of toxicology.
- To make understand mechanism of action and metabolism of toxicants.
- To study biotransformation of toxicants.

Course outcomes:

Students will be able to:

- Learn basic concepts of toxicants, toxicity and dose-response relationship.
- Study metabolism and mode of action of toxicants.
- Understand biotransformation and bioaccumulation of toxicants.

Unit-I: Basic Concepts of Toxicology **(11 h)**

- Toxicology: Definition, history, scope, basic divisions and goals of toxicology
- Toxicants and toxicity:
  - Definition and concept
  - Factors that influence toxicity
  - Toxicity of chemical mixtures
- Dose:
  - Definition
  - Selection of dose
  - Effect and response of dose
- Dose-response relationship:
  - Graded/quantitative response
  - Quantal/quantum response
- Statistical concept of toxicity:
  - Concentration-response relationship/ Threshold limits
  - Criteria for effects and LD_{50}

Unit-II: Absorption, Translocation and Excretion of Xenobiotics **(12 h)**

- Membrane permeability and mechanism of chemical transfer
- Absorption of Xenobiotics:
  - Gastro-intestinal tract
  - Skin, Lungs
  - Parenteral administration
- Translocation of Xenobiotics:
  - Membrane Barriers
  - Binding of xenobiotics to plasma proteins
  - Storage depots: Body fats, brain tissue, erythrocytes and other storage depots
- Excretion of Xenobiotics:
  - Renal excretion
  - Biliary excretion
  - Gastro-intestinal tract

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- Expired air
- Sweat, Saliva
- Milk, Vaginal secretion

Unit-III: Mode of Action of Toxicants **(11 h)**

- Effect of toxicants on structural proteins, enzymes, carriers, coenzymes, nucleic acids and lipids
- Receptor Concept:
  - Definition, location and chemical nature
  - Categories of receptors
  - Mechanism of action of receptors
  - Factors affecting functions of receptors
  - Concept of agonism and antagonism
  - Role of receptors in toxicology
- Mechanism of action of commonly used toxicants:
  - Metals
  - Pesticides
  - Environmental carcinogens
  - Teratogens
  - Ionizing and non-ionizing radiations

Unit-IV: Biotransformation of Toxicants **(11 h)**

- Biotransformation: Definition, sites, principal objectives
- Mechanism of biotransformation
- Phase I reactions:
  - Oxidation
  - Reduction
  - Hydrolysis
- Phase II reactions: conjugation reactions
- Factors affecting biotransformation
- Biotransformation of DDT
- Bioactivation
- Antidotes/antagonists:
  - Definition and classification
  - Mechanism of antidotal therapy
  - Antidotal procedures

References:

- Klaassen C. D. (2008), Casarett and Doull's Toxicology- The Basic Science of Poisons, 7th edition, The McGraw Hill Companies Inc.
- Hayes A. W. and Kruger C. L. (2014) Hayes' Principles and Methods of Toxicology, 6th edition, CRC Press.
- Harbison R. D. (1998) Hamilton and Hardy's Industrial Toxicology, 5th edition, Mosby.
- Ung-Mu Lee, Sam Kacew, Hyung Sik Kim (2017) Lu's Basic Toxicology: Fundamentals, Target Organs, and Risk Assessment, 7th edition, CRC Press.
- Lipmann M. (2009), Environmental toxicants – Human Exposure and Their Health Effects, 3rd edition, Wiley Interscience.

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- Sharma P. D. (2003), Toxicology, 2nd edition, Rastogi Publication, Meerut.

Methods of Teaching:

- Classroom teaching, Lecture method, ICT enabled teaching

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M.J.COLLEGE(AUTONOMOUS)JALGAON

T.Y. B.Sc. (Biochemistry): Semester V
Skill Enhancement Course (SEC)
BC-360: Introductory Bioinformatics

Total Hours: 30 **Credits: 2**

Course objectives:

- To accustom students with concept of bioinformatics.
- To attune students with various biological databases.

Course outcomes:

Students will be able to:

- Understand concept of bioinformatics.
- Understand applications and scope of bioinformatics.
- Understand various biological databases.

Unit-I: Introduction to Bioinformatics **(15 h)**

- What is Bioinformatics?
- Definition of Bioinformatics
- Bioinformatics-A Multidisciplinary approach
- Bioinformatics-the brain of Biotechnology
- History of Bioinformatics
- Applications of Bioinformatics
- Scope of Bioinformatics
- Bioinformatics in India-the flourishing future

Unit-II: Biological Databases **(15 h)**

- Primary database
- Secondary database
- Composite database
- Nucleotide sequence database
  - GeneBank
  - EMBLDDBJ
- Protein sequence databases
  - SWISS-PROT protein sequence database
  - Translated EMBL (TrEMBL)
  - Protein information Resource (PIR)
  - UniProt
  - PROSITE
  - Pfam
  - OWL: A composite protein database
  - Non Redundant DataBase (NRDB)
- Structural databases
  - Protein Data Bank (PDB)
  - Molecular Modeling Database (MMDB)
  - Nucleic Acid Database (NDB)
  - SCOP (Structural Classification of Proteins)
  - CATH (Class Architecture Topology Homology)

References:

- Mount D.W., (2004), Bioinformatics- Sequence and Genome Analysis, 2nd edition, Cold Spring Harbor Laboratory Press, New York, USA.
- Zvelebil M., Baum J. O., (2008), Understanding Bioinformatics, Garland Sciences Taylor and Francis Group, USA and UK.
- Lesk A.M., (2019), Introduction to Bioinformatics, 5th edition, Oxford University Press, UK.
- Pevsner J., (2015), Bioinformatics and Functional Genomics, 3rd edition, Wiley Blackwell, USA.
- Sharma V., Munjal A., Shanker A., (2011), A Textbook of Bioinformatics, 1st edition, Rastogi Publications, Meerut.
- Chikhale N.J., Gomase V.S., (2007), Bioinformatics Theory and Practice, Himalaya Publishing House, Mumbai
- Rastogi S.C., Mendiratta N., Rastogi P., (2015), Bioinformatics- Methods and Applications, 4th edition, PHI Learning Pvt. Ltd., Delhi.

Methods of Teaching:

- Classroom teaching, Lecture method, ICT enabled teaching

HEAD
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T.Y. B.Sc. (Biochemistry): Semester V
Discipline Specific Core (DSC) Course
BC-367: Practical course in Techniques in Plant Biotechnology & Molecular Biology-II

Total Hours: 60 **Credits: 2**

Course objectives:

- To accustom students with Techniques in Molecular Biology.
- To understand the applications of BLAST.
- To study Techniques in Plant Biotechnology.

Course outcomes:

Students will be able to:

- Prepare MS media and will have knowledge about macro and micro elements.
- Perform various plant tissue culture techniques.
- Separate DNA fragments by agarose gel electrophoresis.
- Perform restriction digestion and PCR.

Sr. No.	Topic Particular	Hours
1	Preparation of MS media for PTC.	04
2	Development of somatic embryo from suitable tissue.	04
3	Development of seedling by aseptic germination of available seed.	04
4	Development of shoots by shoot tip culture method.	04
5	Development of callus from suitable tissue.	04
6	Isolation of protoplast.	04
7	DNA digestion using restriction endonucleases.	04
8	Separation of restriction digestion fragments by agarose gel electrophoresis.	04
9	Amplification of DNA fragment using PCR.	04
10	Separation of fragments produced by PCR by agarose gel electrophoresis.	04
11	To study cell membrane permeability using potato.	04
12	Perform BLAST of the given DNA sequence.	04
13	Perform BLAST of the given protein sequence.	04
14	Demonstration of isolation of plasmid from micro-organism.	04
15	Demonstration of Southern blotting.	04

***Mandatory to perform any 12 practical from above.**

References:

- Sadasivam S., Manickam A. (2018), Biochemical Methods, 3rd edition, New Age International Pvt. Ltd.
- Aneja K. R. (2003), Experiments in Microbiology, Plant Pathology and Biotechnology, New Age International Pvt. Ltd.
- Sawhney S. K., Singh R. (2001), Introductory Practical Biochemistry, Narosa Publishing House, New Delhi
- Rao B. S., Deshpande V. (2005), Experimental Biochemistry A student companion, I.K. International Pvt. Ltd., Mumbai
- Jayaraman J. (1996), Laboratory manual in Biochemistry, Wiley Eastern Ltd.

Methods of Teaching:

- Laboratory method, Lecture cum demonstration methods

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T.Y. B.Sc. (Biochemistry): Semester V
Discipline Specific Core (DSC) Course
BC-368: Practical course in Immunology and Toxicology

Total Hours: 60 **Credits: 2**

Course objectives:

- To accustom students with immunological methods.
- To make students aware about toxicological methods.
- To understand the applications of immunological and toxicological methods.

Course outcomes:

Students will be able to:

- Differentially count WBCs.
- Know the importance of cross matching of donor's and recipient's blood.
- Perform various immunological Ag-Ab tests.
- Determine LC_{50} value, effect of temperature and pH on toxicity of pollutant.

Sr. No.	Topic Particular	Hours
1	Differential counting of WBCs	04
2	Blood group detection and cross matching	04
3	Ag-Ab reaction by Ouchterlony double diffusion method	04
4	Radial immunodiffusion.	04
5	Widal agglutination test (slide test method).	04
6	VDRL test.	04
7	Demonstration of ELISA and its significance.	04
8	Determine the relative amount of antigen/antibody in serum sample using precipitin ring test.	04
9	Determination of LC_{50} value of a pollutant by using suitable test animal.	04
10	Determination of the effect of temperature on the toxicity of a pollutant.	04
11	Determination of the effect of pH on the toxicity of a pollutant.	04
12	Qualitative evaluation of pesticide residues in vegetable samples.	04
13	Qualitative evaluation of pesticide residues in fruit samples.	04
14	Qualitative evaluation of pesticide residues in food samples.	04
15	Determination of combined toxicity of pollutants on suitable organism.	04

***Mandatory to perform any 12 practical from above.**

References:

- Sharma S., Sharma R. (2016), Practical manual of Biochemistry, Scientific International Publisher and Distributor, New Delhi.
- Maheshwari N. (2008), Clinical Biochemistry, Jaypee Brothers, Medical Publishers.
- Godkar P. B., Godkar D. P., Textbook of medical laboratory technology, 2nd edition, Bhalani Publishing House, Mumbai
- Sadasivam S., Manickam A. (2018), Biochemical Methods, 3rd edition, New Age International Pvt. Ltd.
- Sawhney S. K., Singh R. (2001), Introductory Practical Biochemistry, Narosa Publishing House, New Delhi

HEAD
DEPARTMENT OF BIOCHEMISTRY
M.J.COLLEGE(AUTONOMOUS)JALGAON

- Rao B. S., Deshpande V. (2005), Experimental Biochemistry A student companion, I.K. International Pvt. Ltd., Mumbai
- Subramanian M. A. (2010), Toxicology, Principles and Methods, 2nd revised edition, MJP Publisher, Chennai.

Methods of Teaching:

- Laboratory method, Lecture cum demonstration methods

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T.Y. B.Sc. (Biochemistry): Semester V
Discipline Specific Core (DSC) Course
BC-369: Practical course in Analytical Biochemistry and Enzymology

Total Hours: 60 **Credits: 2**

Course objectives:

- To accustom students with various analytical techniques.
- To study enzyme kinetics practically.
- To understand importance and applications of immobilization techniques.

Course outcomes:

Students will be able to:

- Perform enzymology related practical.
- Perform separation of mixture using chromatography and electrophoresis.
- Immobilize enzyme/yeast cell and can explore it.

Sr. No.	Topic Particular	Hours
1	Estimation of maltose by DNSA method.	04
2	Isolation of α-amylase from suitable source.	04
3	To determine the effect of amylase concentration on the rate of reaction.	04
4	To determine the effect of substrate concentration on the activity of amylase.	04
5	To determine Km and Vmax of the reaction catalysed by amylase.	04
6	Determination of α-amylase activity and its specific activity.	04
7	To study effect of suitable inhibitor on α-amylase activity.	04
8	To determine the effect of pH on activity of amylase.	04
9	To determine the effect of temperature on activity of amylase.	04
10	Immobilization of suitable enzyme/yeast cells.	04
11	Separation of amino acids using Paper layer chromatography.	04
12	Separation of amino acids using Thin layer chromatography.	04
13	Separation of amino acids using paper electrophoresis.	04
14	Separation of protein by SDS-PAGE.	04
15	Separation of proteins by native PAGE.	04

***Mandatory to perform any 12 practical from above.**

References:

- Sadasivam S., Manikam A. (2018), Biochemical Methods, 3rd edition, New Age International Pvt. Ltd.
- Sawhney S. K., Singh R. (2001), Introductory Practical Biochemistry, Narosa Publishing House, New Delhi
- Rao B. S., Deshpande V. (2005), Experimental Biochemistry A student companion, I.K. International Pvt. Ltd., Mumbai
- Plummer D. (2017), An Introduction to Practical Biochemistry, Indian Edition, McGraw Hill Education.

Methods of Teaching:

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HEAD
DEPARTMENT OF BIOCHEMISTRY
M.J.COLLEGE(AUTONOMOUS)JALGAON

Skills acquired and Job prospects for the Biochemistry students

Biochemistry is the molecular basis of life. Degree program in Biochemistry teaches students the way several lifeless chemicals combine to produce a functional living organism. A significant attraction of the course is the ability to combine in-depth scientific knowledge with practical laboratory skills and the career opportunities in all sectors.

After successful completion of three years degree course in Biochemistry, student will be well versed with laboratory skills and transferable skills.

Laboratory Skills:

- Laboratory safety practices as well as aseptic techniques
- Accurate weighing and reagent preparation
- Skillful handling of basic and advanced instruments
- Calibration of basic instruments like pH meter, micropipettes etc
    - Advanced techniques like; Chromatography, Electrophoresis
    - Spectrometry, Polymerase Chain Reaction (PCR)
    - Plant Tissue Culture, Animal Tissue Culture
- Collection, organization and presentation of data
- Analysis, Logical thinking and, interpretation of results

Transferable Skills:

During the course student will develop skills other than laboratory skills that are transferable across the number of career areas which include;

- Analytical skill, Observational skill
- Planning and Time management
- Mathematical and IT skills
- Creative thinking, Problem solving
- Report writing skill, Presentation skill

Job Opportunities:

After successful completion of B.Sc. in Biochemistry, student may continue further studies like M.Sc. in Biochemistry and then Ph.D. in Biochemistry and make career in research field. Students have opportunities in private as well as public (Government) sectors.

Private Sector:

Biochemist can work in quality control, quality assurance and R & D divisions of companies like-Biotech companies, Pharmaceutical companies, Chemical manufacturing companies, Food and Drink (includes brewing), Health and Beauty Care, Medical Instrument companies, Agricultural companies, Research Companies and Laboratories etc.

Public Sectors:

HEAD
DEPARTMENT OF BIOCHEMISTRY
M.J.COLLEGE (AUTONOMOUS) JALGAON

Blood Service, Cancer research institutes, Environmental Pollution Control, Forensic Science, Hospitals, National Blood Services, Overseas Development, Public Health Entities, Public Health Laboratories, Agriculture and fisheries etc.

Job profiles:

Biochemist, Biologist, Biomedical Scientist, Biotechnologist, Chemical Examiners, Chemist, Clinical Scientist, Food Scientist, Forensic Scientist, Laboratory Technician, Microbiologist, Research Associates, Research Officers, Research Scientist etc.

Opportunities in higher studies

After successful completion of B.Sc. in Biochemistry, student may continue further studies like M.Sc. in Biotechnology / Biochemistry and pursue higher studies. Even students can pursue other courses where graduation is essential.

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